Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

CHAPTER FIVE

Food security challenges and opportunities in indonesia post COVID-19

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1. Introduction

The spread of Covid-19 has made human life more difficult, as people have struggled more to fulfill their needs. This became worse when the WHO declared the virus disease a pandemic. This decision was based on the rapid growth of Covid-19 worldwide (Pung et al., 2020). The situation led policymakers to enact a lockdown or activity restriction policies.

However, some countries cannot implement the policy due to a massive impact on their economy (Paital et al., 2020). Indonesia is one of many

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countries that could not avoid the Covid-19 pandemic, with a death toll that continues to increase. This pandemic is affecting not only the health sector but also the financial sector. These two sectors' crises can have worse effects on other sectors. Many efforts have been made and continue to be made to counter the pandemics effects. If one effort fails, another is attempted.

The government, as the policy or regulation maker, cannot deal with the pandemic alone; all of society must participate. It is not easy, but all parties need to be proactive. Vaccines have also been regulated, and some people already been vaccinated. However, the effort does not stop there; they still need to apply health-related measures in their daily life. Some experts have observed that people need to get used to Covid-19 because this virus will remain in human life in some form. In other words, people need to live with Covid-19 forever.

All sectors affected by the pandemic tried to survive, but some were worse hit than others. Agriculture, as one of the sectors most impacted by the Covid-19 pandemic, has become a vulnerable sector (Wang et al., 2020). Even without a pandemic, this sector was vulnerable. Agriculture is a complex issue for a country like Indonesia, with many people still relying on this sector. The government or related parties experience challenges in developing agriculture. This sector is closely related to food security because it naturally plays a vital role in supplying and protecting food availability. Farmers, as the main actors in agriculture, face a complex situation in this pandemic, especially regarding fluctuating prices, increasing input prices, and health issues. Aging farmers also make agriculture more vulnerable. Meanwhile, in the pandemic era, agricultural product marketing is more challenging due to decreasing social interaction. These complicated problems need to be considered in making policy regarding regulation during and after the pandemic.

Indonesia, like other developing countries, has a long history of food security issues. Three main components in food security are food availability, food accessibility, and food stability. Along with the development of food security theory, food utilization has become an important issue that needs to be considered in food security efforts. Impacts on agriculture, transportation, and activities restriction regulation make food security in Indonesia more challenging, but of course there are also opportunities. Therefore, this chapter discusses the challenges and opportunities of food security in Indonesia after Covid-19. A comprehensive perspective regarding food security before and after the pandemic is presented using literature review and secondary data.

2. Covid-19 in Indonesia

2.1 Nobody was ready for Covid-19

Covid-19 is believed to have been first detected in Wuhan, China, at the end of 2019, and some scientists predicted it came from animals. In, 2020 the virus spread rapidly around the world. Nobody was ready for this virus. Developed countries, developing countries, and growing countries face the same challenges raised by the pandemic. Through the WHO, the world has tried to identify the source of the virus and to create suitable policies and develop vaccines. China, the USA, Russia, and other countries have worked to develop vaccines.

The race to develop vaccines has two sides: handling pandemic and or business opportunities. There are four types of Covid-19 vaccine that are now being developed (as seen in Fig. 1). Some have already passed the clinical trial stage and have been injected into many people around the world. People who have been vaccinated still need to protect themselves and others by wearing masks in public spaces. Moreover, a new strain of Covid-19 has been found, and it has become more challenging for governments and

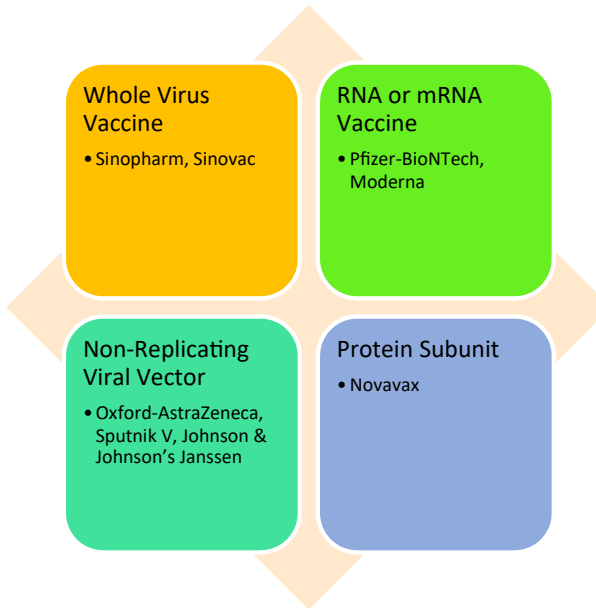

Fig. 1 Type of Covid-19 vaccine (McArthur, 2021).

related stakeholders to protect people. This new challenge has come when governments are still racing to implement vaccine programs to respond to the current pandemic wave.

The Indonesian government announced the country's first Covid-19 case in March 2020. Although the official response was not as fast as that of neighboring countries, Indonesia kept trying to handle Covid-19. First thoughts of Covid-19 included that related stakeholders were not really afraid that this virus would spread fast and impact human life in Indonesia. This thought was based on the virus spread appearing to be faster in some colder (nontropical) countries than in warmer countries (Jahangiri et al., 2020). Indonesia, as a warm country, was thought to be less likely to experience significant effects from the virus. Unfortunately, the reality was different where the virus rapidly spread and government actions were considered slow.

Anyone can check the current situation through the official website of the government (https://covid19.go.id). With this open information system, the Indonesian government wants to show that the fight against the Covid-19 pandemic is all parties' responsibility, and the government cannot deal with the pandemic alone. Chen et al. (2020) showed that people tend to access the information regarding the number of cases rather than regarding the handling, guidance, and appreciation; therefore, they are likely to be shared with hoax news. With the one information source system, misinformation and hoaxes can be anticipated.

The first wave of the Covid-19 pandemic indicated that the government and its people were not ready; the virus rapidly spread around the country (Sun et al., 2020). Various actions have been taken to handle the virus, but seem insufficient to stop the spread (Sun et al., 2020). With no preparation for Covid-19, special measures are needed (Harapan et al., 2020). The prediction regarding the development of the virus was also slow, even though this prediction was vital to establish the appropriate countermeasures against the pandemic (Tuli et al., 2020).

Meanwhile, other countries implemented a total lockdown to prevent the spread of the virus (Mandal and Pal, 2020). However, Indonesia did not apply the mechanism due to economic issues, as lockdown was believed to bring devastating effects to the economy (Djalante et al., 2020). Instead, Indonesia applied large-scale social restrictions in some of the Covid-19 spread centers, such as Jakarta, during which only vital activities were allowed to be carried out.

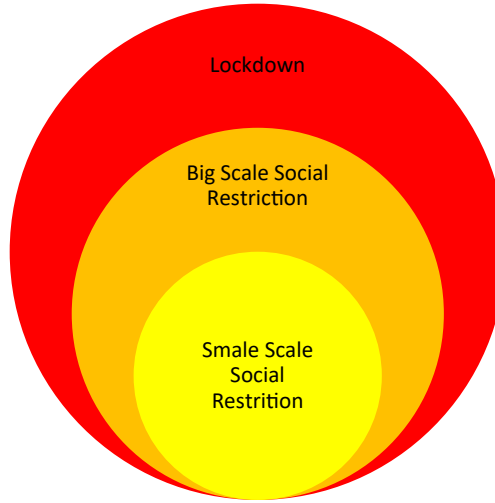

Fig. 2 Level of social activities restriction in Covid-19 (the author).

In general, there are three actions regarding how the country or region handles the spread of the virus: lockdown, large-scale social restrictions, and small-scale social restrictions (Fig. 2). The biggest restriction is lockdown, where virtually all outside activities are prohibited. Large-scale social restrictions (Indonesian: *Pembatasan Sosial Skala Besar* (PSBB)) are looser than lockdown. Some characteristics of PSBB include limiting activities in public spaces, working and educating children from home, limiting entrances and exits to some areas, closing tourist destinations, banning dining in at restaurants, and limiting prayer houses to only local people (Azhari, 2021). Meanwhile, in small-scale social restrictions, people may still run their businesses, but the operational hours are shortened. For social activities, gatherings of many people still cannot be conducted, and/or the number of participants is limited (Farisa, 2021). However, small-scale social restrictions are believed to have no significant effect on preventing the spread of Covid-19. The reason is that these restrictions allow everyday activities, only with shorter interaction time. Lastly, the action taken could involve no restrictions at all. This action is based on considering reliving the economic situation caused by the pandemic, especially for small businesses.

Social or activity restrictions are short-term measures to handle the pandemic. For long-term measures, related parties must predict the evolution of the Covid-19 pandemic in the future and how long it will last. Tomar and Gupta (2020) showed that Covid-19 predictions are only accurate

within a specific range and are only a beneficial tool for administrators and health officials. Even developed countries cannot make precise predictions regarding the future condition of Covid-19. Cássaro and Pires (2020) added that predicting Covid-19 is not accessible due to many issues such as the dynamic of the spread, vigorous human activities, individual protection level, transmission rate, etc. Furthermore, these cannot be done without widespread participation, such as scientists, government, civilians, privates, etc. (Djalante et al., 2020). For instance, in the tourism sector, restriction policies impact the tourism locations where activities were closed at the beginning of the pandemic. Now, the restriction policy involves limiting the working hours and visitor numbers (Cahyadi and Newsome, 2021).

2.2 Impacts on human life

That Indonesia is the fourth most populous country globally, with more than 250 million, makes this country more likely to suffer from this pandemic. The impact of this pandemic is varied. As shown in Fig. 3, the impacts of the Covid-19 pandemic can become worse and cause national instability.

2.2.1 Health crisis

The Covid-19 pandemic has caused all regions in the world to face health crises. Moreover, Covid-19 cases are increasing globally. Health protocols such as wearing masks have been proven to prevent infection (Écochard et al., 2021). The pandemic is different from health crises that the has world faced before, as the current virus spread is extremely unpredictable, and the virus could mutate into a stronger one. A health crisis occurs when the numbers of sick people are unexpectedly high and continue to increase, while local health facilities are insufficient to handle the situation. In Indonesia, in some areas, the health facilities are almost fully occupied.

The health crisis consists of two primary conditions: the massive number of people infected and limited health facilities. Some experts in Indonesia were worried regarding the availability of hospitals to support the fight against Covid-19. In mid-2021, 2922 public hospitals were available in Indonesia, but those hospitals are centered in Java Island. Among those

Fig. 3 Covid-19 impact level (the author).

hospitals, 134 are national referrals and 791 are province referrals (National Committee for Covid-19 Handing and Economic Recovery, 2021). To support the fight against this pandemic, however, the health facilities in Indonesia are seen in concerning condition, while the numbers are not high enough to meet situational requirements, and some areas are not even equipped.

The number of Covid-19 cases in Indonesia, as of mid-2021, is still growing. The government has stated that Indonesian people need to adapt and live with Covid-19 because this virus will remain in this world indefinitely. Even though many have already been vaccinated, experts say that people still have to be cautious.

The distribution of infected cases in Indonesia is spread all around the country. On April 3, 2021, in Indonesia 1,527,524 people were infected with Covid-19, 1,366,214 had recovered, and 41,242 had died. To handle the pandemic, the vaccine program has been regulated with a total target of 181,554,465 people. The program is being carried out gradually based on priority such as health workers, public workers, education workers, and the elderly (National Committee for Covid-19 Handing and Economic Recovery, 2021).

The vaccine program is still going until it reaches its target. Compared to other countries, Indonesia is relatively slow in vaccinating its people, but is working hard to do so as quickly as possible. The country has also developed its vaccine through related institution consortiums, such as the Ministry of Health and scientists. They are trying their best to keep pace with the pandemic. Indonesia can use available vaccines from other countries, but developing its own vaccine is a different story, intended to show that Indonesia can also carry out vaccine development. For the long-term program, using a home-made vaccine is most economical and sustainable. As the majority religion in Indonesia is Islam, consumption is restricted to only halal products, including medicines and vaccines. If the vaccine that Indonesia develops can succeed, the halal condition can be guaranteed more easily. Now Indonesia is using two vaccine brands: Sinovac and AstraZeneca. Sinovac was certified halal by the Indonesia Moslem Council from the beginning. However, AstraZeneca was not, as pig-derived material is present in this vaccine. However, in an emergency, AstraZeneca can be used. This situation shows that Covid-19 pandemic handling measures are very dynamic, as culture and religion are considered. Any contradiction or rejection due to local culture and/or religious beliefs should be considered in making any regulations or actions. Even if the regulations or actions are reasonable, they will fail if they are not welcomed by society.

Investment in health infrastructure is vital to increase the facilities and services for fighting the pandemic. Also, public awareness, such as applying health measures by wearing masks and keeping distance, needs to be increased to establish the best way to prevent the virus transmission (Wen and Su, 2021). Community behavior is an important part of preventing further virus transmission. A government response is needed to make the efforts more effective. These efforts to prevent an increase in infected cases will help to ensure the health crisis does not worsen (Abbas, 2021) and must be made by all society. At the beginning of the pandemic, many people thought that the elderly were more likely get infected, but experts have since stated that individuals of all ages experience risk of Covid-19 infection, so all people need to be more careful (Jester and Kang, 2021).

2.2.2 Economic crisis

Covid-19 could destroy people's livelihoods, businesses, industries, and the whole economic sector (Laing, 2020). It does not see the developed or developing countries; all have the same risk (Asyary and Veruswati, 2020). Chakraborty and Maity (2020) added that the pandemic is disrupting the global economy; even developed countries are also threatened by the pandemic, especially those relying on exports for income and imports for various national needs. To control the health crisis, human activities are restricted to some degree. These restrictions are significantly affecting the economy. Shops are not allowed to operate; even if they can sell, nobody will buy. People cannot go to work; even if they could go to work, access is limited. People in Indonesia, especially low to middle income people, are suffering during the pandemic.

Indonesia experienced an economic crisis in 1997. This condition led to many negative effects on social life and chaotic situations in many areas (Winarso and Firman, 2002). Fig. 4 shows how an economic crisis is generally caused by national issues. The first national issue is the noneconomic sector crisis. If a country has a national crisis in a central sector such as social or security, that country's economy will be in crisis. The second is foreign affairs policies. With a global free market agreement, countries that closed their borders and will not collaborate with other countries will be left behind and suffer financially. With the world dynamics as they are now, a country cannot live by itself, but needs to collaborate with other countries. The third issue is debt and or inflation. Indonesia experienced the debt trap and its worst inflation in 1997–1998. At that time, the country fell into an economic crisis. The fourth is limited resources. A country that does not

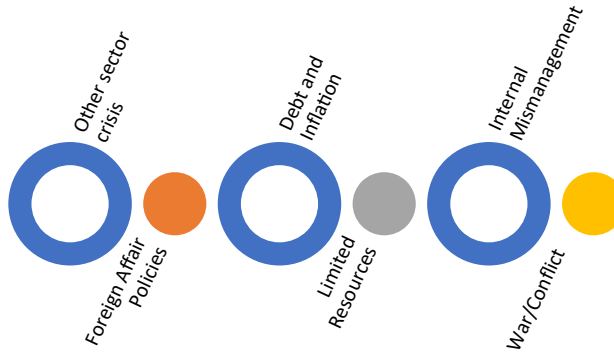

Fig. 4 The cause of economic crisis (the author).

have enough resources usually cannot develop well and is often trapped in debt. This situation leads to an economic crisis. The fifth issue is internal mismanagement. Even a rich country will fall into an economic crisis if the government is corrupt and management is not appropriately conducted. The sixth is war or conflict. This situation forces the country into a crisis in all sectors. Many countries cannot move forward due to war or conflict.

Speaking of a crisis caused by a pandemic, a crisis hotline is used in many countries to handle the increasing numbers of infected cases. This crisis hotline assists people who need help regarding the disease. Economic recovery is also significant in the Covid-19 pandemic relieving program, such as revoking the various restrictions in economic and social activities (Arendt et al., 2020). The pandemic has close relation with the economic crisis due to health and inequality crises. Policymakers are crucial in maintaining a good economic situation (Shipton et al., 2021). The triggers of an economic crisis in developing countries vary, depending on each country's specific situation (Aswicahyono et al., 2009).

The economic crisis has a significant effect on society, especially for those within low-income households. Protecting the economy from the crisis due to the pandemic has become a challenge. Many companies were liable to collapse, especially small and medium enterprises (SMEs). They were hit by the drastic decrease in peoples consumption or outside activities. These SMEs could not sell their product or services (Simms and Rowson, 2003).

Indonesia is a large country with more than 17,000 islands, and the densest one is Java Island, although its area is only around 7% of the countrys total land. Each area in Indonesia has a different characteristic, including human behavior, environment, and population. The health facilities are also

different in each area. Rozaki (2020) showed that the health facilities such as hospitals and ventilators to fight against Covid-19 are still centered in Java Island, which has the densest population. The risk of this pandemic is the same for Java and the other islands. Therefore, the health crisis that affects the economic crisis is varied among areas; it cannot be generalized the economic crisis condition. Moreover, autonomy of regulation gives the local governments more opportunities to decide their own rules. Economic crisis could bring Indonesia to the worst condition, such as the significant fall of GDP (Aswicahyono et al., 2009).

The economic crisis has a big impact on society and can lead to a social crisis. The economic crisis during the pandemic is closely related to the labor market, the decline of peoples purchasing ability, and consumption (Gandasari and Dwidienawati, 2020). Forecasting future pandemics regarding economic and food conditions, especially during the current pandemic, is a must. Even actions such as food waste need to be stopped by any means (Malefors et al., 2021).

During the Covid-19 pandemic, many countries have shown a deficit in communication (coordination), leadership, and flexibility. Less coordination cannot make the situation better because each party has its own interest. At this time, strong leadership is very important, but flexibility is also essential to ensure that every regulation is not conducted by force (Beilstein et al., 2020). Aron et al. (2021) showed (as seen in Fig. 5) that there are some strategies to handle the pandemic. The first is expanding the intensive care capacity. This is very important especially to provide enough and good health facilities and other supported instruments for infected people. Second, due to the impact of the pandemic, many people lost their jobs, and many enterprises could not survive. Therefore, parts of the workforce require redeveloping and retraining. Third, for handling large areas and rich diversity, providing Covid-19 information, viral testing, and appropriate follow-up for a geographically dispersed population are needed.

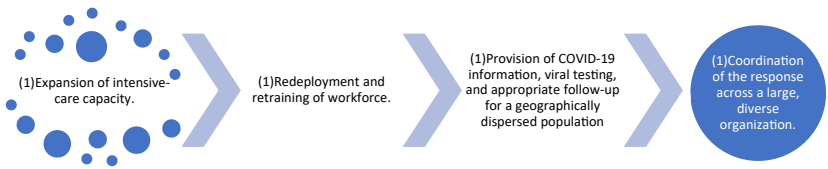

Fig. 5 Strategies to handle the pandemic. *Modified from Aron, J.A. et al. 2021. Strategies for responding to the COVID-19 pandemic in a rural health system in New York state. Healthcare, 9 (2), 100508. doi: 10.1016/j.hjdsi.2020.100508.*

Furthermore, as a fourth point, all parties, both public and private, need to collaborate, coordinating the response across large and diverse organizations.

One of the leading causes of the economic crisis is unemployment (Hotchkiss and Jacobalis, 1999). The increase of unemployment in the midst of the pandemic has contributed significantly to the economic crisis. People who lost the job can relay to the loan. Loans are dangerous because many people cannot pay them back, causing loan companies to go bankrupt. This situation is not hoped in the life of the middle low-income community.

The economic crisis that accompanied the Covid-19 pandemic is different from earlier economic crises. The characteristics are different, yet if there are no special measures to handle the crisis, this can lead to considerable instability for other sectors and ultimately other sector crises (Aktar et al., 2021).

Indonesia experienced an economic crisis from 1997 to 1998, and it was not easy to recover from the crisis due to domestic and foreign affairs (Nasution, 2002). In addition, the country's political system, which is democratic, becomes another challenging issue as the local governments are allowed to make local policies regarding the current issue, such as the crisis or other issues. On one side, autonomous regulation lets local governments take faster actions regarding their own problems. On the other side, central government policies are sometimes rejected by these local governments. For example, regarding the restriction policy during the pandemic, the central government did not want to enforce a lockdown policy due to the fear of economic crisis, but some areas were implementing lockdown or large-scale restrictions. Moreover, for middle- to low-income people during the pandemic, they were more focused on how they can continue to eat than how they could protect themselves from getting infected. Therefore, many people broke social restrictions to keep themselves fed by continuing to work (Mukiibi, 2020).

2.2.3 Social crisis

Loss of income could lead to social instability (The Lancet, 2020), as it causes people to be depressed and they may do anything to fulfill their needs. Social restrictions on a large and small scale in Indonesia bring side effects—people get depressed easily. Usually, they are going out and enjoying life either while working or on vacation. They are now forced to stay at home, and they cannot move freely. Social restrictions, including lockdown, could freshen the air quality, help fix the environmental issues, and significantly decrease air pollution and fossil fuel usage (Mahato et al., 2020).

Nevertheless, these benefits are considered not to be comparable with the negative impacts from the restrictions, especially in terms of economics and individuals mental health.

A social crisis can occur if the economic crisis and the restriction continue to happen, where people cannot work, and do not have savings. They still have to feed their family while being forced to limit their activities, which leads them to break the regulations, and increases the crime rate. The sense of unfairness is exacerbated by the release of many convicts from prison by the government to prevent Covid-19 rapid infection inside the cells. Despite the opposition of many parties to this regulation, the government still carried it out. According to the Ministry of Law and Human Rights, this regulation has extra strict consequences such as if the resealed convicts after their releasement were to commit the crime again, they would be captured and put in a special cell. In addition, only some qualified prisoners were to be released based on the designated qualification (Wicaksana, 2020). Even with strict consequences, unfortunately, the authority found that some residivist were committing crimes again. This situation makes people are more worried. First, they do have difficulty in economic, and second, they are worried about the increase of the crimes, even it is not limited to the crimes that come from the released convicts and other parties that have an economic problem and forced them to commit crimes.

Common crimes such as burglary might decrease during social restrictions as people are leaving their homes less (Mohler et al., 2020). however, this restriction might increase domestic violence due to the intensive interaction between the potential offender and the victim. In addition, the more intense family interaction and the unplanned pregnancy rate in Indonesia increased during the pandemic (Putri, 2020). This situation has caused a problem in family planning, as the government encourages families to have two or fewer children children. Thus, the pregnancy rate booming during the pandemic generates another challenge for the government to control the birth rate.

With the various social issues from pandemic effects, solidarity among people is increasing during the pandemic. It shows that there are always good people to demonstrate good actions to help others in crisis or hard times. Indonesia, as an eastern country, has social capital that interaction between people is close, they are thinking about unity. The gestures of solidarity during a pandemic could help some people in need and who are suffering from not being able to fulfill their daily necessities. The gestures are varied, such as providing free raw food materials and other daily needs. During the pandemic, collective actions have driven social solidarity in rural areas and

in the cities to fight the pandemic together (Mishra and Rath, 2020). In addition to showing that people care for others in hard times, this solidarity shows that solid social capital still exists in society.

2.2.4 Security crisis

The impacts of the Covid-19 pandemic on human life cannot be ignored. The crisis, both economic and social, can develop into a security crisis. All parties hope to avoid this crisis because the impact of a security crisis is huge on national stability for all sectors (Fig. 3). Conflict and chaos can arise if no measures are taken to control the crisis. Many examples show that a security crisis can lead a country to destruction in all areas of life. For example, in the Middle East, or some African countries, Southeast Asian countries such as Myanmar, or particular areas in the Philippines, security crises are happening. Indonesia experienced a security crisis during the economic crisis in 1997–1998, where many of its cities were in chaos. Malls and other shopping centers were looted, and instances of racial hate increased drastically. At that time, Indonesia was in an unstable condition; some parties stood up and declared a reformation of the government system. However, it was not easy to stabilize national security. This example shows that a security crisis could bring massive destruction to national stability and development. Geopolitics may play a role in the security crisis, and much propaganda has been conducted to make their own benefits.

3. Food security in Indonesia

3.1 Never-ending food security struggle

Indonesia is the fourth most populous country globally, with more than 270 million people in 2020. Large population countries have the same issue regarding food security. With no expansion for the land area, population growth will threaten food availability. Fig. 6 shows that Indonesia had a positive population growth rate from 1961. From the 10 years of census data, the country shows significant population growth in the period. The trend of population growth decreased to 2.1% in 1971 and 1.25% in 2020. Even though the rate of population growth is decreasing, the overall population is increasing quite significantly. More population means more food is needed. Java, as the center for rice production, has become the center of the population. Data shows that 56.10% of the population is centered on Java Island (Statistics Indonesia, 2020a). This means that agricultural land is also decreasing due to land conversion to housing.

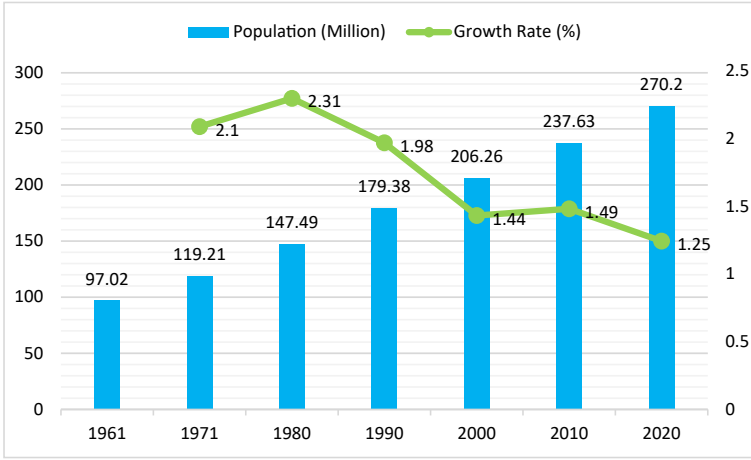

Fig. 6 Indonesia population 1961–2020 (Statistics Indonesia, 2020a).

Family planning (Indonesian: *Keluarga Berencara (KB)*) started to become a government concern in the 1950s. This program was initiated and launched as one of the methods to control the population. In 1970, the government formed the Indonesian National Family Planning Coordination Board (BKKBN) to intensively support the family planning program (Utomo et al., 2006). Controlling the birth rate is often cited as the main element in a nation's ability to improve its economic and social welfare (Molyneaux and Gertler, 2000). The family planning program commonly targets families in rural areas with a high birth rate (Andriani Lubis and Wijaya, 2017). This problem leads families into a hard time when they usually only rely on the agriculture sector, which involves unreliable incomes. Rural areas in Indonesia are still dominated by people working as farmers. Talking about the family planning which targeting rural area, mean it has effect to the farmers. Miller and Babiarz (2016) showed that the family planning program has an effect on the socio-economic welfare of its targets (individuals and families).

As the country where agriculture is still the main livelihood for most people, Indonesia has a large responsibility to keep agriculture reliable for many farmers' families. Agricultural problems such as small landholding, lack of mechanization, cost increase, human resource, and marketing ability make farmers' lives more susceptible, more over when families' members are big so there are more mouths to be feed. To fulfill families' needs is not easy in this situation. There are two ways to survive for Indonesian farmers: increasing their income from agriculture or controlling the family

size (family planning). The government and other parties are developing technologies and other supporting programs to increase the agricultural economy. However, it is hard for a complex sector in its management because agriculture relates to many factors such as environment, human resource, input, etc. that are sometimes impossible to control. The family planning method is believed to help farmers manage their economy while only relying on agriculture. The smaller the size of the family, the smaller the living costs of the family. Often this meaning is not understood by farmers, who mostly have a low education background. They choose to have many children to receive more welfare, according to the slogan "More kids, more welfare. Each kid definitely has their own fortune."

Food security generally consists of four components: food availability, food accessibility, food stability, and food utilization (Fig. 7). These four components must be fulfilled if food security is to be achieved. Food availability means the food is available; it is not limited to local or foreign production, as long as the food is available, it is fine. Food accessibility means people can access the food, including the food being affordable, and people can buy it at an accessible place or market. Food utilization means people can utilize food in the correct way for their health and nutrition. The ideal food security criteria are calories, poverty, dietary diversity, and subjective indicator (Headey and Ecker, 2013). Dietary diversity indicators are the best-performing class of indicators: they are potent predictors of

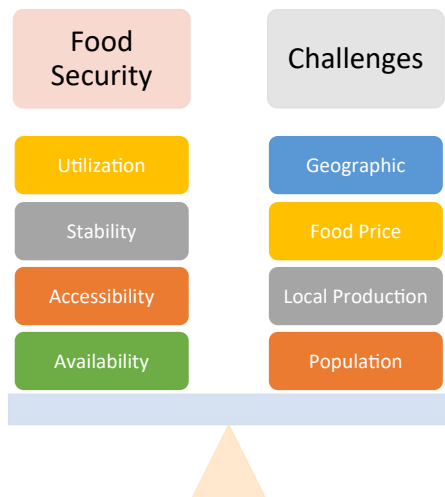

Fig. 7 Food security components and challenge (the author).

economic status and malnutrition (both stunting and wasting), sensitive to shocks, and relatively cheap to measure. Greenville et al. (2020) stated that food security based on the 1996 World Food Summit is the situation "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."

Meanwhile, food stability means that food can be available and accessible all the time by all households and/or individuals. This stability can be said to be included in the dimensions of availability and accessibility. To achieve these food security components, all parties need to collaborate and show their contributions. The food security efforts are multisector and multidimension works; the government alone cannot fulfill them. Nevertheless, food security is not easy as the theory; there are some challenges in fulfilling food security. These challenges include a population that continues to grow, local production that tends to decrease, the disparities in prices among areas, and geographic challenges, especially in Indonesia, as many areas are difficult to reach, and/or access to particular areas may involve extra costs. This can cause food prices to double or more.

Kulsum and Chryshna (2020) explained that food security in Indonesia historically continues to develop and has a different approach in each government era. The Old Order era (President Soekarno era) had focused on food security for rice self-sufficiency: "*swasembada beras*." In the New Order era (President Soeharto era), the government focused on three assumptions: concept, measurement, and strategy. Within these assumptions, there were three periods of 5 years of planning: rice self-sufficiency (1969), food self-sufficiency (1979–1989), and return to rice self-sufficiency (1989–1998). In the era of President Susilo Bambang Yudhoyono, there was again a focus on agriculture revitalization and self-sufficiency in five food commodities: rice, maize, sugar, beans, and beef. The Joko Widodo presidency also focused on food self-sufficiency, followed by some programs such as paddy creation, farming corporation, and community food barns.

The food security rate in Indonesia varies by region, and depends on regional resources and wealth. More prosperous regions will not have a problem regarding food security. If they cannot achieve food self-sufficiency, they can import food from other areas. Meanwhile, more impoverished regions with limited resources will struggle to fulfill food needs for their people. Regarding the food security rate, some measurements commonly being used are as follows:

1. Household Food Insecurity Access Scale (HFIAS)

   This measurement is commonly used to measure the food security condition at the household level using a designated questionnaire. This method is based on the idea that the experience of accessing food insecurity causes predictable reactions and responses that can be captured and quantified through a survey and summarized on a scale (Coates et al., 2007).

2. Food Security Index

   Through the Food Security Bureau Republic of Indonesia (2020), Indonesia publishes a Food Security Index every year. There are indicators to analyze this index, including:

   - ratio of normative consumption per capita to net availability;
   - percentage of population living below the poverty line;
   - percentage of households with a proportion of expenditure on food of more than 65% of total expenditure;
   - percentage of households without access to electricity;
   - average length of school for girls is more than 15 years;
   - percentage of households without access to clean water;
   - ratio of population per health worker to population density;
   - percentage of children under five with stunting; and
   - life expectancy at birth.

Kulsum added that some indicators could be used to measure food security. The first is production rate, availability, consumption, and food trade; the second is the ratio of food availability and consumption; the third is the level of food availability and consumption; the fourth is food security condition; the fifth is the condition of community food reserve institutions; and the sixth is the ability to stock food.

Fig. 8 shows a food security map based on the Food Security Bureau of the Republic of Indonesia. It indicates that some areas in Indonesia are still in vulnerable or alarming conditions, such as Papua and West Papua. Java Island and Sulawesi Island, in contrast, are areas with a very strong food security condition. Bayu (2021) explained that the Economics Intelligence Unit analyzed the Food Security Index with the Global Food Security Index (GFSI). The result shows that Indonesia's Food Security Index is fluctuating; generally, it shows an increasing trend (Fig. 9).

Flood (2010) explained that the increase of food prices in the food security issue becomes another challenge in terms of food security issues. In Indonesia, the food price fluctuation rate is high. Often the measures from the government were not enough to control prices, and efforts to control food prices are crucial to food security (Anderson et al., 2013). Indonesia

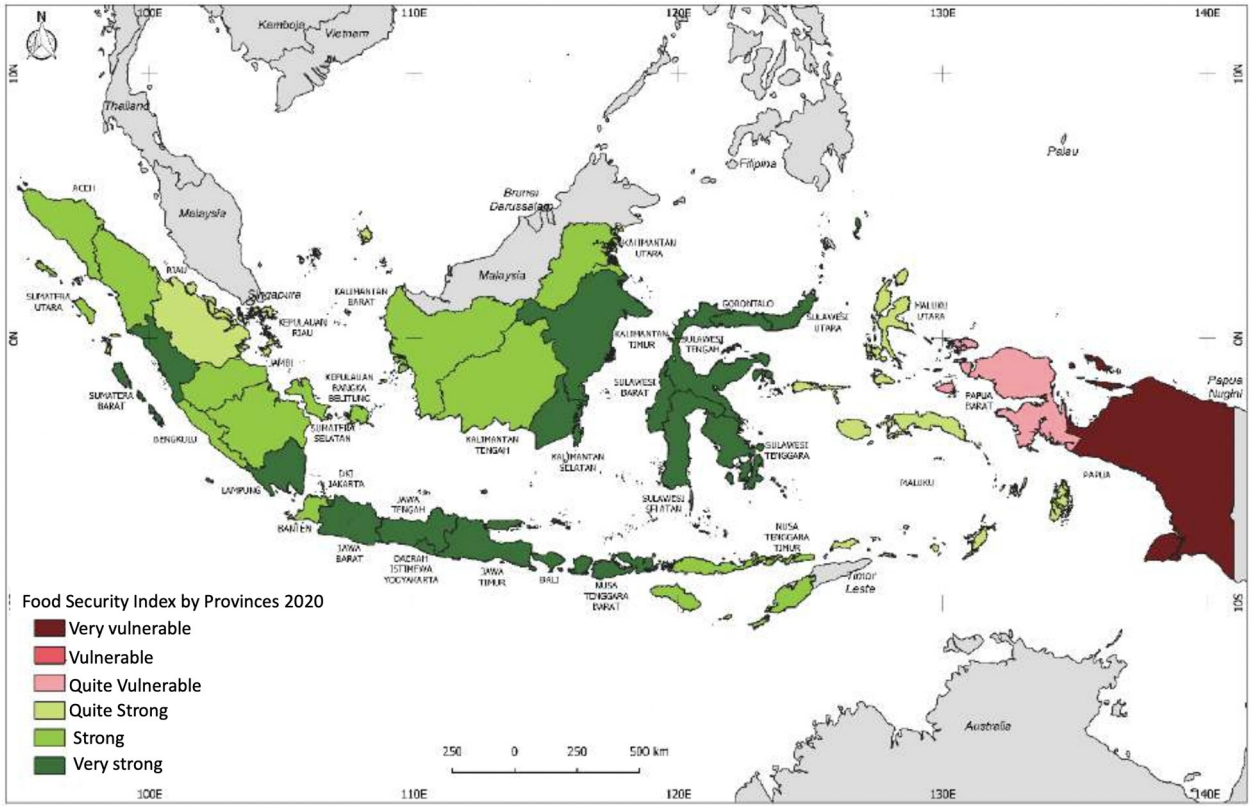

Fig. 8 Food security map by the Food Security Bureau Republic of Indonesia (2020).

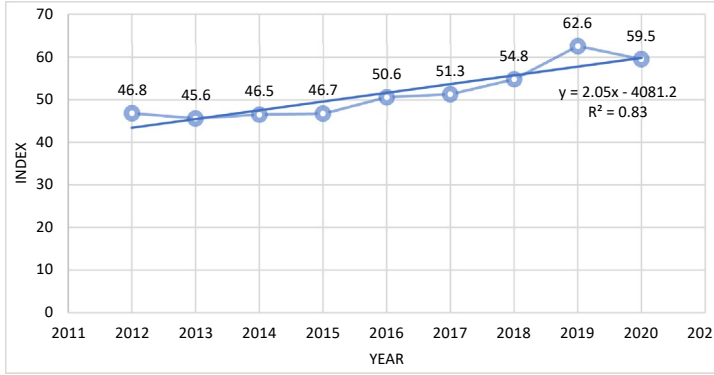

Fig. 9 Food Security Index of Indonesia (GFSI) (Bayu, 2021).

uses the Indonesian Bureau of Logistics to control rice prices by lowering the rice prices in the middle of the hiking prices. This can control prices for a short period only. Furthermore, the increase in rice price occurs often. The price hike, over and over again, is a severe problem for food security. Flood (2010) added that before the Covid-19 pandemic, food price hikes were already becoming a big problem, especially with the increasing number of poor households. This increased the suffering of families during the pandemic. Many middle-income people could not survive, and it was worse still for low-income people. Farmers also faced more problems during the pandemic when they lost their harvests due to pest attacks or other disasters (Rozaki et al., 2021).

In addition, the food security agenda needs to consider the environment and sustainability (Negin et al., 2009). Increasing the production with overuse of input, especially chemical input, can repeat the mistake that happened in the Green Revolution in the 1980s. At that time, Indonesia could achieve rice self-sufficiency, but the impact on the environment was not good—the land was affected by overfertilizing, and pests and diseases became more resistant to pesticides and other chemical materials (Shiferaw et al., 2013). Therefore, management demand with food diversification and sustainable intensification combines better crop resistance to disease and pests, and reduces water, fertilizer labor, and fuel. Mechanization also needs to be considered because the labor problem during a pandemic will not significantly affect agriculture if mechanization is applied well. In achieving food security, information, mechanization, and farm-level production are important (Masters et al., 2015). Cai et al. (2020)

added that some factors that are important in food security are the levels of agricultural development, the purchasing power of residents, regional accessibility, and political and economic stability.

3.2 Food self-sufficiency—still a dream?

Indonesia is known for its agriculture sector. Generally, with solid agriculture, food self-sufficiency will be easier. However, for Indonesia, food self-sufficiency is something that is moving further away from the expectation. In the 1980s, Indonesia could achieve rice self-sufficiency: "*Swasembada Beras*." However, it was believed that some agricultural problems appear, such as rice fields that become reliant on chemicals and pests that become more resistant. In 1984, Indonesia declared it had achieved rice self-sufficiency. Yet despite the national production of about 27 million tons that could meet the national consumption of 25 million tons, the government still imported the rice to secure its needs. Suwarno (2010) added that Indonesia is still using rice self-sufficiency as the main indicator for food availability as a critical aspect in food security. Forcing rice cultivation to increase rice production has a severe effect on future rice production. The higher the level of rice yields achieved will lead to closer genetic potential, resulting in difficulties in increasing further yields and the existance of greater risks. Therefore, there has been a slowdown in rice production and food self-sufficiency for the population, going to be very unstable. To solve this issue, Indonesia is advised to expand its paddies to increase rice production.

The current situation of agriculture production to ensure food availability is still dominated by rice. Fig. 10 shows that rice has the highest production compared to other food production. From 2014 to 2018, rice production increased. It was followed by cassava and maize. In some parts of Indonesia, maize has become the staple food.

Regarding the import situation, as seen in Fig. 11, rice and soybean have become routinely imported by the government. This import policy is believed to fulfill the food needs and/or secure food availability and become a political issue. When imports occur during harvest time, this situation negatively affects farmers' lives because the relevant food price will significantly decrease. It thus does not bring benefits for farmers. From 2014 to 2019, the rice import every year was around 20 million tons. Indonesia is a net importer for almost all of its staple foods, especially rice (Warr and Yusuf, 2014). National food self-sufficiency, in this term, is rice, become the

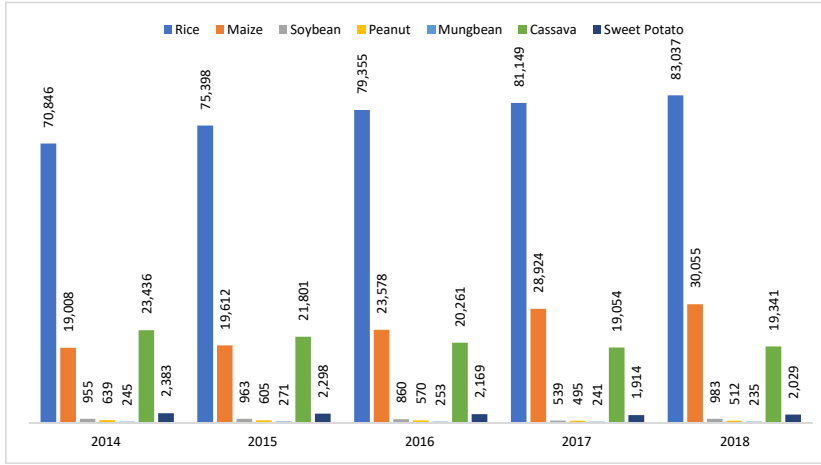

Fig. 10 Agricultural production in thousands of tons (Rozaki, 2020).

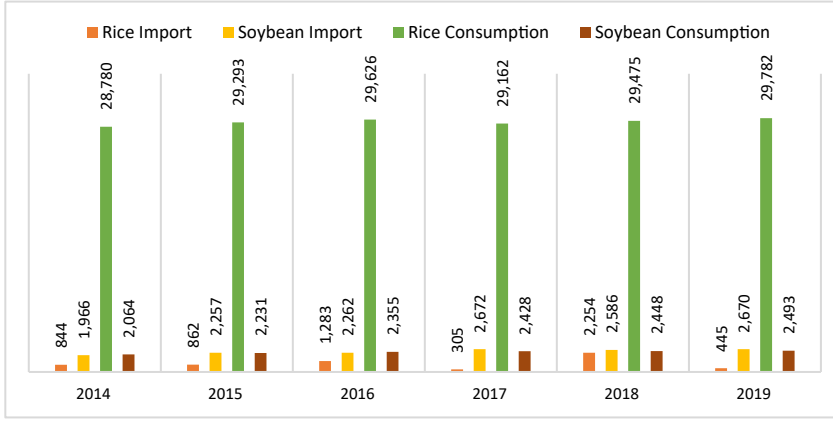

Fig. 11 Import and consumption of rice and soybean in thousands of tons (Rozaki, 2020).

one of economic policy in Indonesia. Meanwhile, soybean, though it is not a staple food, has become a culture food like *tempeh* or tofu that everybody eats. Regardless of their social status or wealth, people can consume this product and receive high nutrition. This ensures high demand for soybean and causes the government to import soybean to fulfill the demand.

When thinking about food security, policymakers also need to consider how the food is produced and how the demand is maintained for a particular food product. This theory can be applied to diversify food consumption.

It can help to reduce the rice demand and make it easier to fulfill the food need with other food products such as maize, cassava, and other carbohydrate products.

3.3 Agricultures long history in Indonesia

The history of agriculture in Indonesia is a long one. Originally, those living in Indonesia were practicing agriculture to survive. Fig. 12 shows the history of agriculture. The first is about the history of how people are practicing agriculture. In the past, people hunted for food hunter to fulfill their needs. After that, they tried to farm according to the nomadic system; they would do land clearing in a specific place. Once production in that place became unreliable for farming, they would move to another place to clear the land and farm it. However, this system was not suitable for the environment, and people became tired of moving on regularly. So they changed the system to be settled in one place. To maintain the lands condition, they use fertilizer and control pests and diseases.

Regarding agricultural product utilization, at the beginning of practicing agriculture, people only consumed their products by themselves. Then they start to exchange their agricultural products for other goods that they needed. Moreover, as money was used, farmers started to do trade to fulfill their needs not only in terms of food.

The history of agriculture in Indonesia is also related to subsistence and commercial agriculture practices. The majority of farmers in Indonesia are smallholders. This forces farmers to optimize limited landholdings to produce food. With limited farmland, production is also limited, causing some farmers to consume the products by themselves or not sell the products.

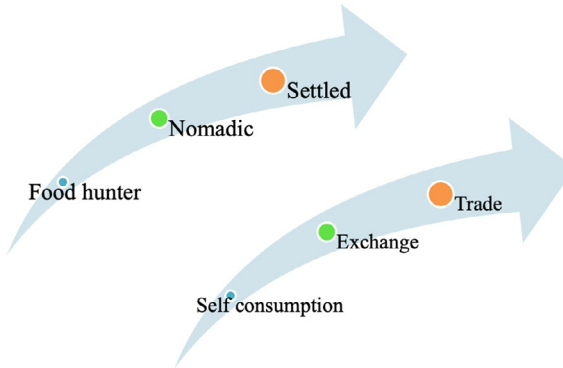

Fig. 12 History of agriculture (the author).

Agriculture in Indonesia is still in transition between subsistence and commercial; logically, smallholder farmers are not able to work on a commercial scale due to limited farm sizes. The only option is intensification. Subsistence agriculture relies on human power, few animals or machines, smaller average farm size, most food being consumed by the farmer and family, and the farm being owned by a family.

In contrast, commercial agriculture relies on capital investment in machinery, large average farm size, the product sold to the company, and fewer family-owned farms. Ricciardi et al. (2018) stated that smallholders (under 2 ha) globally generate 28%–31% of total crop production and 30%–34% of food supply on 24% of the gross agricultural area. Although smallholders have low production, they are also less likely to suffer harvest loss than big farms.

Based on Anderson et al.'s (2013) research, agricultural self-sufficiency is 0.95 and will decrease to 0.83 in 2030. Agricultural production needs to be developed, and marketing efficiency also needs to be improved (Grote, 2014). This can be achieved by integrating the agriculture sector with other sectors such as energy and finance. Relying on local production for fulfilling food security needs to focus on increasing production (Bishwajit et al., 2013). Developing countries such as Indonesia often relying on imported food is not a wise choice because it is not sustainable. Importing is a short-term solution for food shortage and/or securing food availability (Sulser et al., 2011).

Like in other countries, agriculture in Indonesia plays an important role in providing food and contributing to many benefits such as the source of livelihood, national revenue, marketable surplus, source of raw material for various industries, foreign exchange resource, economic development, etc. Because of these contributions, the agriculture sector is still a key one in Indonesia's economy. It contributes 13.70% to Indonesia's GDP (Abdurachman, 2021), and is the second biggest after the industry sector with 19.88%.

3.4 Classic challenges in agriculture

Nephawe et al. (2021) explained that food security has a strong relation with agriculture productivity. It depends on environmental conditions such as water availability, soil fertility, etc. In Indonesia, beyond that environmental condition, there are some classic challenges (Fig. 13). With many challenges, the agriculture sector has become a vulnerable sector.

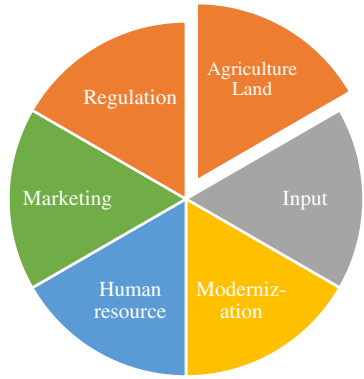

Fig. 13 Agriculture classic challenges (the author).

3.4.1 Agricultural land

Other challenges regarding agricultural land facing farmers and smallholders is that agricultural land is getting smaller due to expansion of industries and/or settlements. Fig. 14 shows the development of paddies in Indonesia from 2003 to 2019. It shows that paddies in Indonesia are fluctuating year by year and were decreasing in 2018 and 2019. As one of the most stable areas for paddies, Java Island is changing its land use to industrial and/or residential due to the increasing population. Even though some local governments issued a regulation not to change the use of agricultural land in certain areas, agricultural land conversion increases year by year.

The government considers that it is challenging to increase agriculture production to support food security without expanding the agricultural land. Therefore, the government made regulations to create new agricultural land out of Java Island. This program is called "Food Estate." It was created by the Jokowi Presidency, creating new land of 190,000 ha for agriculture in Central Kalimantan, specifically in Kapuas Regency and Pulang Pisau Regency. The Ministry of Agriculture is carrying out this program, along with the Ministry of Public Works and Public Housing, and the Ministry of Defense, between 2020 and 2022. For the next target, the food estate will be expanded to 120,000 ha in West Kalimantan, 10,000 ha in East Kalimantan, 190,000 ha in Maluku, and 1.9 million ha in Papua (Lasminingrat and Efriza, 2020). However, some parties are worried about the impact of this program on the environment and specifically forests in the area.

Fig. 14 Paddies in Indonesia (Secretariat General Ministry of Agriculture, 2020; Statistics Indonesia, 2015).

Prabhakar (2021) explained that the agricultural land-use change could lead to a negative impact. The main driver is the increase in population and their needs. Nevertheless, with intensification efforts, agricultural production can be kept up. Yet this intensification can negatively affect the declining total factor productivity, the decreasing of land fertility, soil erosion, and land degradation. However, he added that with policy intervention and good coordination of land management, the negative impact from the land-use change could be addressed. Meyer and Früh-Müller (2020) showed that the land-use change to settlement or infrastructure is quite remarkable. Without any quick intervention, such as regional planning or payment for maintaining agricultural land, the settlement development will considerably outcompete agriculture in a prosperous area. The economic reason will lead farmers to abandon agriculture. Chrisendo et al. (2020) explained that land-use change in Indonesia is a common trend in tropical countries, where it has profound environmental and socio-economic implications.

3.4.2 Inputs

Inputs in agriculture are crucial for this sector's development. The input consists of seed, fertilizer, and plant protection products such as pesticides, herbicides, etc. The main aspects of input in agriculture are availability and accessibility. These two aspects must be considered in every policy regarding agriculture inputs.

3.4.2.1 Availability

Agriculture can succeed if the inputs are available and sufficient for farming. The long history of agriculture has changed land fertility time by time. Along with time, land needs more fertilizer. This issue also happens for other inputs, such as pests or diseases. More negligible crop diversification can lead to pests or diseases that are more resistant to the plant protection products. Therefore farmers are commonly applying more and more plant protection products on their farmland. To guarantee fertilizer availability, the government established a state company that has focused on producing fertilizer to help Indonesian agriculture sinch 1959, when PT Pupuk Sriwijaya was established, and in 2012 the name was changed to PT Pupuk Indonesia.

Due to a large amount of fertilizer usage compared to other inputs, input availability is more about fertilizer availability. State companies like PT Pupuk Indonesia also focus on providing both subsidized and nonsubsidized fertilizer. The majority of farmers in Indonesia are relying upon inputs from the subsidy. This is not about willingness to pay, but more about the ability to pay. Farmers with small farmland cannot earn much profit if the input price is high, because agriculture is an economic activity with many uncertainties and much reliance on natural conditions. If any problem comes from nature, the possibility of harvest loss is higher. In certain times in Indonesia, fertilizer scarcity is felt by many farmers. This scarcity relates not only to subsidized fertilizer but also to nonsubsidized fertilizer. This problem often occurs when farmers cannot be found easily, even for nonsubsidized fertilizer. Fertilizer demand for Indonesia's agriculture is very high. Strong regulation to secure fertilizer availability is a must.

3.4.2.2 Accessibility

Accessibility regarding the agriculture input relates to the fact that the inputs are affordable and can be bought by all farmers. Even though the inputs are freely available, if the price is too high and/or farmers cannot buy it due to some circumstances, the accessibility condition is not met. Input subsidy is one strategy to make the inputs affordable. This program has also becomes one of the strategies to fight poverty-related issues within the agriculture sector, relating to farmers. Because poverty in developing countries such as Indonesia has a strong relation with agriculture, agriculture becomes the livelihood of many rural people.

In Indonesia, the subsidy program for agriculture inputs is mainly for fertilizer because the fertilizer need for farming is huge in every farming season compared to plant protection products. Fig. 15 shows the government

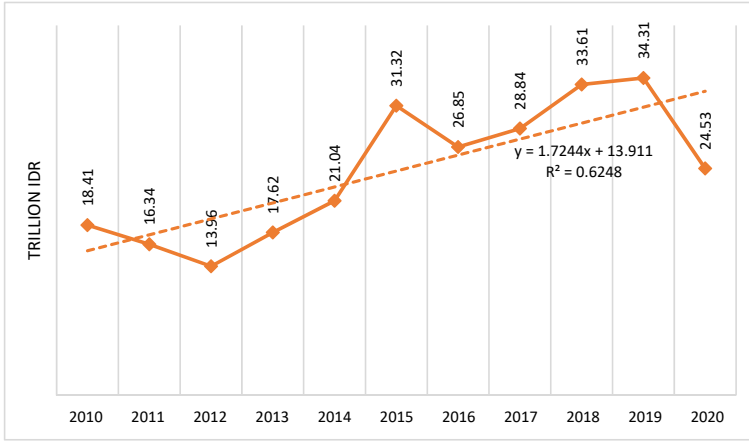

Fig. 15 Fertilizer subsidy (Directorat General of Infrastrucutre Ministry of Agriculture Republic of Indonesia, 2021).

budget for fertilizer subsidy from 2010 to 2020. The trendline shows R^2 0.6248, which means the trend is significantly increasing. The highest subsidy was given in 2019 with 34.31 trillion IDR. With the fertilizer subsidy program, Indonesia hopes to increase rice production because those benefiting from fertilizer subsidy are mainly rice farmers and the rice production factor is not only the fertilizer. Since the 1970s, Indonesia had used agricultural input subsidies, especially on fertilizer, to stimulate agricultural production, in the pursuit of rice self-sufficiency, and this program will be more effective to increase the production and support food security by stopping imports (Warr and Yusuf, 2014). Osorio et al. (2011) found that most farmers benefit from fertilizer subsidies; however, 40% of farmers capture up to 60% of the subsidy, and the overuse of fertilizer will affect future yields, decreasing land productivity.

The fertilizer subsidy program has some regulations regarding technical implementation. In terms of price, the program forces the retailer to obey the highest retail price for subsidized fertilizers. For example, in 2021, the highest retail price for urea is IDR 2250, and ZA (Zwavelzure Amonium) is IDR 1700. Other regulations focus on how the farmers can buy the subsidized fertilizers. The Ministry of Agriculture of the Republic of Indonesia has regulated the technical flow to buy subsidized fertilizer, where the farmers buying the subsidized fertilizer must show *Kartu Tani* (Farmer Card). Before the farmers can buy the subsidized fertilizer, there are several verification procedures by extension advisors and the

local agriculture bureau (Directorate General of Infrastructure of the Ministry of Agriculture Republic of Indonesia, 2021). Actually, the problem regarding the input accessibility is the price. The regulation to increase the price can lead to a significant loss for farmers because they rely on inputs.

3.4.3 Human resources

Every sector needs this very important input. Even though some industries are using robots with artificial intelligence, the input of human resources is still needed. This input has become something that agricultural sector in developing countries relies on heavily. Manpower or human resources in agriculture has become a vital input parameter (Busato and Berruto, 2016). Wise management is needed due to the high relation with cost. Mechanization in Indonesia is not like in developed countries, where mechanization has become common and all areas can be mechanized. Indonesia still needs human resources that drive the agriculture sector. There are four main challenges to human resources in agriculture: availability, quality, aging, and motivation (Fig. 16).

From a demographic point of view, Indonesia does not have problems. Some experts say that Indonesia has a demographic bonus due to its high birth rate, and the number of young people is higher than that of older people. Fig. 17 shows the rural and urban populations in Indonesia. The data explain that the urban population is continuing to grow while the rural population is decreasing. Rural areas in Indonesia are dominated by

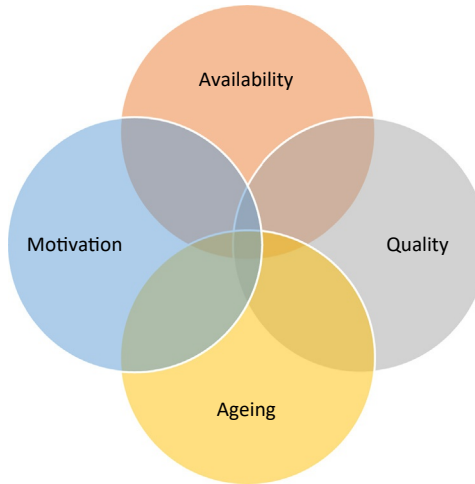

Fig. 16 Human resource challenges in agriculture (the author).

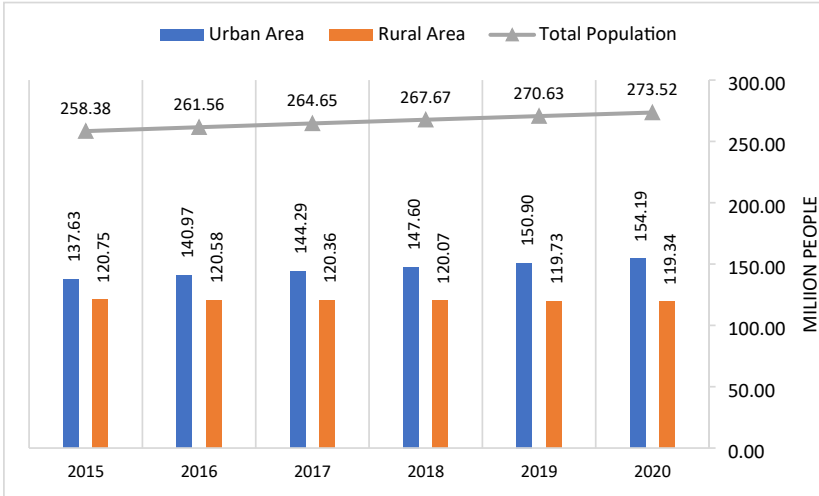

Fig. 17 Indonesia population based on area (Jayani, 2019).

agriculture as a livelihood. Yet along with the development of technologies, many rural people migrate to the city for better jobs. This trend will lead the rural sector and agriculture into a hard time and one that gets harder. Urbanization means the migration of rural people to urban areas, which is not a new trend. This phenomenon also happened in the past, where people gathered in an area that provided more income opportunities.

3.4.3.1 Availability

The availability of human resources in agriculture is critical, especially in developing countries, where agriculture relies on manpower rather than machines. In Indonesia, many farms are still relying on manpower. Only in some areas are farmers starting to use machines due to their simplicity and the difficulties in finding manpower. The manpower need in agriculture is usually in the periods of planting and harvesting.

Mechanization has become the solution for the lack of manpower. A book by Sulaiman et al. (2018) explained the agricultural mechanization revolution in Indonesia. There are some challenges in developing mechanization. The first is capital. Farmers in Indonesia are mostly smallholders, who often do not have enough capital to buy the mechanization equipment. Even though some financial institutions and or government programs provide loan access, it is still difficult for farmers to pay back the loan.

The second is the land condition. The topography of Indonesia's agriculture is commonly hilly and not flat, which makes it difficult to operate the machines. The third is manpower. Agriculture is still a sector that absorbs much manpower. In rural areas, many people rely on agriculture as their source of income. With mechanization, the job opportunities for them from agriculture can decrease. The fourth is the availability of experts in agriculture mechanization. There are still few experts who can maintain mechanization in agriculture, especially in rural areas where many farmers are less educated.

3.4.3.2 Aging Farmers

Aging farmers are everywhere all around the world. Countries with a demographic problem where the increase of older people is greater than the birth rate, such as in Japan and Thailand, face aging farmers as one demographic problem. Young people leaving the agriculture sector have a significant impact on the current and future situation of agriculture (Saiyut et al., 2017). Mayuzumi (2020) added that agriculture is still becoming a second-choice sector; young people will not work as farmers.

For countries that have demographic bonuses, such as Indonesia, aging farmers are also an issue, along with the trend that young farmers are not interested in agriculture. Regeneration in the agriculture sector is very slow and has many challenges, such as uncertain income and future, vulnerability to any external circumstances, nonprestige compared to other sectors, etc. Saiyut et al. (2017) added that the decrease of young labor could not be replaced by the increase of older labor. This condition will reduce the agriculture production potential in the long term. Fig. 18 shows the number of farmers in Indonesia based on age, farmers' predominant age being 45–54 years old with 28.23%, while less than 34 years old farmers only less than 11%. This problem is worsening with the decreasing number of farmers in Indonesia. If this trend continues, the future of Indonesia's agriculture will be at a perilous point. Farmers as the main actor in agriculture cannot be replaced by other inputs. The effectiveness of agriculture activities, as known in this sector, involves many physical activities, and age has a big effect. Older farmers will more likely have less effectiveness; although their experience is higher than that of younger generation, their physical strength is weakening.

3.4.3.3 Motivation

Motivation is very important for people to do something. Without motivation, people will not do certain things. This concept is also applied in the

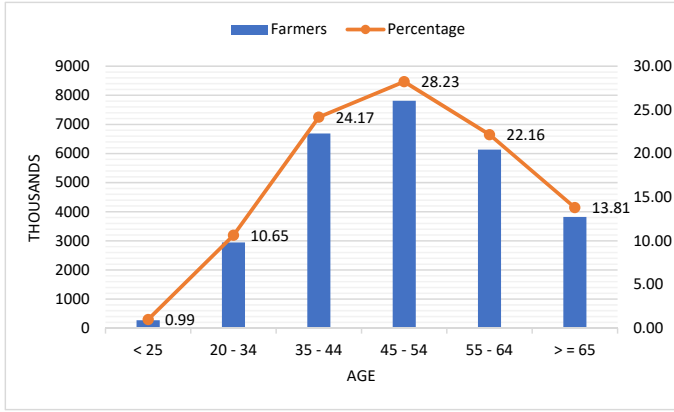

Fig. 18 Number of farmers based on age, 2018 (Statistics Indonesia, 2019).

agriculture sector: people's motivation to practice agriculture is fundamental. Those who live in rural areas, and who are not young, and who only practice agriculture from the beginning of their career, will continue to practice agriculture because they think they do not have a choice: they can only work in agriculture to make a living. However, young people are able to choose to work in agriculture as farmers or to work outside of agriculture. The trend shows that young people are more likely to choose to work in industry, services, and other sectors than agriculture. Some young people are found working in agriculture, but they only sell downstream agriculture business products; they are not producers or farmers or upstream agriculture businesses. The involvement of some young people in the agriculture business, in the downstream, can perhaps be seen as a good sign that young people have the motivation to do agriculture business. Yet how young people can be motivated to work in the upstream of agriculture business is important for the near future. Without any effort to increase the number of farmers by motivating young people to work in agriculture, Indonesia will face serious agriculture problems.

3.4.3.4 Quality

The majority of Indonesian farmers have low education because education was not so important and not compulsory in previous generations. This causes the quality of agriculture actors, the farmers, to be low. The agriculture sector can grow with good innovations, but with low quality of farmers, these innovations are more likely to be rejected or not succeed. The government has given more support to education for those in rural areas and all citizens. The current regulation regarding compulsory education is that

people have to take education until senior high school (total 12 years education). With this regulation, education awareness is increasing and young people are more likely to have a better education.

Indonesia has an extension program to improve the quality and skill of farmers, and to deliver or transfer the innovations in agriculture. The extension program plays an important role in transferring information and technologies (Hasibuan et al., 2019). Extension advisors usually become the hand of the government for any programs for agriculture development. There are four types of extension advisors: government employees, contracted workers, self-help, and private. From 2017 to 2020, the number of extension offices was increasing, though not significantly, with 69,699 advisors in 2017 and 73,695 in 2020. The numbers are the total number of all types of advisors combined. If the data are filtered only by the government employee, these advisors are less than half of the total advisors (Fig. 19). This number is not equal compared with the number of farmers, which is more than 27 million. So, one advisor has to assist more than 400 farmers—this ratio is extremely low. To increase farmers' quality, in addition to increasing the number of extension advisors, farmers' groups are being formed to increase the farmers' coordination, knowledge sharing, innovation discussion, etc. (Rustinsyah, 2019).

3.4.4 Modernization

Modernization is the key to today's agricultural development. Involving machines or mechanization in all parts of agriculture practice can solve some

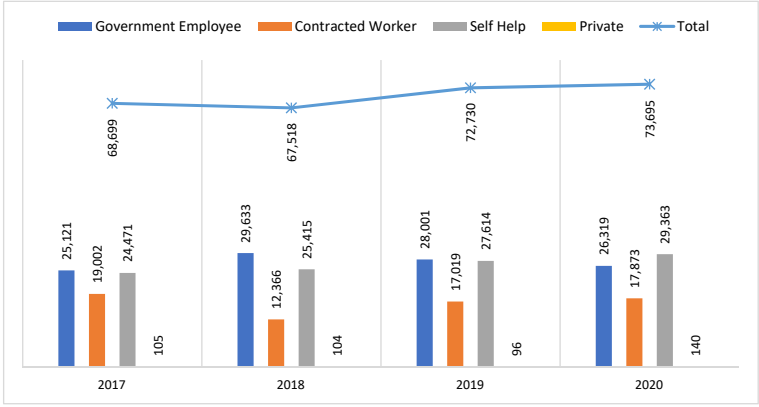

Fig. 19 Extension advisor from 2017 to 2020 (Data and Information System Center Ministry of Agriculture, 2020).

issues such as low production, lack of manpower, effectiveness, etc. The history of modernization in agriculture started when people realized the necessity to increase production. There are two strategies: intensification and extensification. Both strategies have their own challenges. Intensification can be conducted with modernization and innovation. Meanwhile, extensification can be conducted to find suitable land for agriculture. This strategy has a big enemy—land conversion—which extensification needs to race against.

Modernization in Indonesia is more understood as mechanization efforts. Mechanization in Indonesia has a long history and continues to be an input in every strategic planning in agriculture development in Indonesia (Sulaiman et al., 2018). Mechanization can succeed if the machines are suitable (Hasan et al., 2020). These efforts are modernizing agriculture. The challenges of modernization are culture and land characteristics. The culture of some farmers in Indonesia is that they are not entirely comfortable with innovation, including machines. They are happy with what they are used to. The land characteristic means the topography of the land, as some of the agricultural land in Indonesia is difficult to reach by machine.

3.4.5 Marketing

Marketing is an essential part of agriculture to make the products can be sold at the best price. The ability of farmers to sell their products is commonly not so good. Many farmers are selling their products to a broker. This method is the easiest for farmers, but there is a risk that the price is lower than selling directly to consumers. Farmers in Indonesia are very vulnerable with their products. The farmers cannot even control the prices. When the price is high, they will get a good profit, but when the price is low, they do not get any profit or may experience a loss. The instability price is a classic problem in Indonesia, not only for agricultural products but also for other products.

Another factor regarding the marketing issue for farmers' products is the price disparity between farmers and consumers. This problem happens because of the abundance of brokers in the marketing of agricultural products in Indonesia. The price disparity can be twice or more that of the actual price in the farmer's hand. For example, the average national chili price at the farmers' level is IDR 15,000, while at the consumer level, the price can reach IDR 45,000 or more (International Center for Applied Finance and Economics (InterCAFE) IPB University, 2018). It is not the farmers who

benefit from the high price but the brokers and distributors. Chilis, garlic, shallots, and beef are commodities that often come with unreasonable prices. Although they are not primary foodstuffs, these commodities are always sought for by consumers.

3.4.6 Regulation

The government has the responsibility to ensure national food sufficiency through regulations or policies that can support the local production without relying upon foreign products (Funk and Brown, 2009). Svanidze et al. (2019) added that a country that relies on import products is vulnerable to global crises, affecting food prices at the national and local levels. Regulation from the government plays a very important role in agriculture development (Rozaki et al., 2021). All aspects of agriculture should be considered in regulation, such as inputs, assistance, price, etc. In Indonesia itself, there is a trend that regulations often get changed along with the new government era. Agriculture is a complicated sector in its management; therefore, it needs a long period of planning that is locked by regulations. Any regulations in agriculture must consider the diversity of culture, land, and farmers's characteristics because some characteristics cannot be generalized (Schoneveld et al., 2019). Understanding small farmers' characteristics on adapting to environmental change is essential in creating regulation (Lim et al., 2020). There is a possibility that a regulation cannot be applied in certain areas.

The government should convince agricultural workers and other parties regarding any regulation for agriculture development (Hadiprayitno, 2015). Herren (2020) added that regulations have to support local products for food self-sufficiency. Regulations based on regional potency are important in times of crisis, such as the Covid-19 pandemic. Furthermore, any regulations will be more attractive to farmers if the program can improve the farmers' financial situation. Alaerts (2020) stated that economic interests from independent farmers might conflict with government policy or actions. Covey et al. (2020) added that people need to be involved in regulations to make them more accepted and successful.

3.5 Agriculture post Covid-19

The Covid-19 pandemic has impacted all human life sectors, including agriculture. The scared on impacts of this pandemic is high (Nicola et al., 2020). Social restrictions affect the economy, especially businesses that rely on people's outdoor activities such as restaurants, accommodation, transportation,

etc. This has a domino effect on the economic sector. Many businesses cannot survive, so they reduce or cut their employee numbers. The unemployment rate due to the pandemic is high. People lost their jobs and cannot get another jobs easily. Agriculture is still the leading sector that many people rely upon for their livelihood and living (Susanto et al., 2017). This sector was impacted by the pandemic, yet it has been surviving in terms of employment. Indeed, the agriculture sector still needs workers or did not cut employees. Agriculture as the primary sector was less impacted by the pandemic than some other sectors.

The sector impacted most severely by the pandemic was tourism, as people could not travel as much, especially to foreign countries. This also affects the accommodation and transportation sectors. Bali, for example, as a tourism hotspot in Indonesia, contributing much to the tourism sector for national GDP, struggled significantly after getting hit by the pandemic. The Bali economy is dependent on tourism, and quarterly are dependent on tourism-related activities such as transportation, services, and accommodation. Bali was relying heavily on foreign tourists; therefore, with no foreign tourists, and local tourists also visiting less, the tourism sector in Bali has been facing its hardest time. Therefore, the local government is trying to go back to agriculture as the primary sector to support the local economy (Indonesia Expat, 2020). They also realize that local tourists need to be considered to benefit the tourism sector.

Impacts of the Covid-19 pandemic on the agriculture sector vary and have different results in some areas (Bidarti, 2021). Some impacts being felt by agriculture include the increase of inputs price, the decrease of consumer ability to buy, the rebudgeting of government programs on agriculture, farmers' health issues, and the supply chain disrupted by the social restriction program. Perhaps the extensive logistics transportation will not be affected by restriction because the field official will let them transport the goods, but retail transportation may be affected.

Agriculture in Indonesia is relying on inputs to keep production as expected (Funk and Brown, 2009). The increase of input prices such as fertilizer, seeds, and plant protection materials could not be avoided during the pandemic due to the economic sector being hit by the pandemic. Subsidies for those inputs are desired by all farmers as inputs are playing an important role in farming costs, although the subsidies program is not something that can be implemented quickly due to its complicated bureaucracy. The postpandemic agriculture problem continues with the decrease of products' absorption due to decreased consumer ability to buy. Many

people lost their jobs and their businesses, so their ability to buy goods decreased. They thus only focus on primary agricultural products such as rice.

Another problem is that the government rebudget their program, including agriculture. The government shifted the budget for medical support items such as protective instruments, vaccines, medicines, etc. to fight against Covid-19. Farmers' health became an issue during the pandemic because they were not aware enough to apply health measures when performing agricultural activities (Susanto et al., 2017). This trend occurs not only in farmers but also in people in rural areas, where people are not aware enough to protect themselves from Covid-19.

Even though agriculture is also impacted by the pandemic, this sector, as the primary sector in Indonesia, can prove that this sector can survive and become the savior sector. It is because agriculture is producing primary stuff for people's lives, and in the pandemic era, even though many people are having financial problems, their primary needs, such as food, are mandatory (Greenville et al., 2020). At the beginning of the pandemic, food demand was high due to panic buying (Nicola et al., 2020). This condition forced the government to calm the people down and convince them that the food supply was stable and that there was no need to panic. However, in some areas, panic buying still happened. Yet gradually, the panic faded, and the situation improved regarding demand. The balance between demand and supply is important to protect both producers and consumers (Savary et al., 2012).

Food production in Indonesia is still centered on Java Island; other areas are importing the foods. This situation needs transportation from one area to another. During the pandemic, many transport restrictions were applied. Even if the restrictions did not apply for logistics such as food, transportation was impacted, meaning the supply chain of food was disrupted (Herren, 2020). During the pandemic, farmers, as the main actor in agriculture, needed more attention. As in India, the government could provide four actions to help farmers and others: funds for those who lost income; compensation for farmers who lost their farms; buying unsold agriculture products; and providing insurance for medical staff fighting Covid-19 (Mukhopadhyay, 2020).

The Covid-19 pandemic has affected many sectors of the economy. The economic crisis has a significant impact on farmers' lives as they are low-income householders, vulnerable to economic dynamics (Sunderlin et al., 2001). Indonesia shows that the economic dynamics affect agriculture

through the fluctuation of input and output price, where the input is getting higher while the output is getting cheaper. With this condition, sometimes farmers experience deficiencies. In facing the economic crisis, farmers also apply diversification in their farming to make a better living. Benton (2020) stated that after harvesting, during the pandemic, farmers were confused about which commodity to plant because the market was uncertain.

Increasing agricultural production in Indonesia through current available agricultural land seems complicated because the land quality is decreasing due to prolonged usage and overuse of chemical inputs. Intensification strategies might increase production but cannot be significant. Extensification is a promising strategy, but areas in Java Island are already fully occupied. Hence, this strategy would be more prosperous outside Java. The "Food Estate" program mentioned earlier might solve the extensification program. However, the challenge is the land suitability, and in the wake of the Covid-19 pandemic, this program is questionable because the budget and result do not seem to be equal—also, there is an environmental problem from the impact of this program.

3.6 Can everybody access the foods?

Food accessibility has become one aspect of achieving food security. It means that people can access the food for their daily diet and that the food is affordable. With this definition, food accessibility consists of price, market, infrastructure, and distribution (Fig. 20).

3.6.1 Price

Poverty is an important issue in developing countries. It is not only about the poverty line but also about the effect of this issue (Goyal, 2012). Indonesia has a relatively high rate of poverty. Based on Fig. 21, Indonesia's poverty decreased from 39.3 million in 2006 to 26.42 million in, 2020. Based on this statistic, the poverty rate in Indonesia is different from area to area; Papua and Maluku show the highest rates, while Kalimantan shows the lowest. This means that regulation or actions to ensure affordable prices for people may differ according to area. People in impoverished areas are more likely not to be able to afford food. Therefore, food accessibility must take account of poverty when food prices are regulated.

Food prices fluctuate and vary from one area to another. This is caused by characteristics such as accessibility to the area. The easier the accessibility, the cheaper the food price, as the transportation will cost less. Rice prices

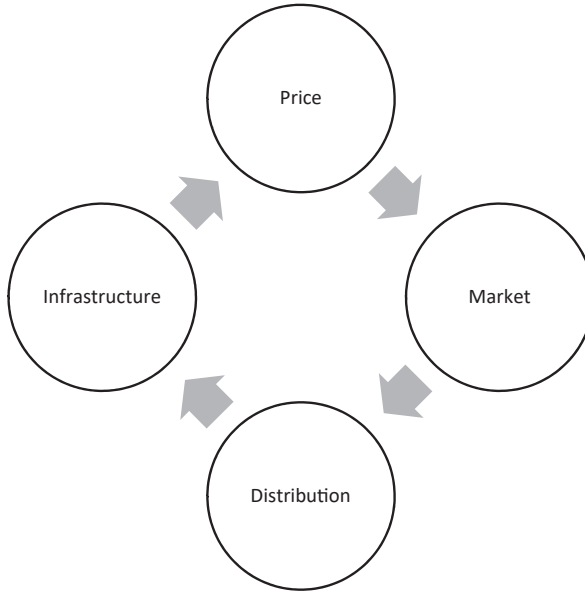

Fig. 20 Foods accessibility aspects (the author).

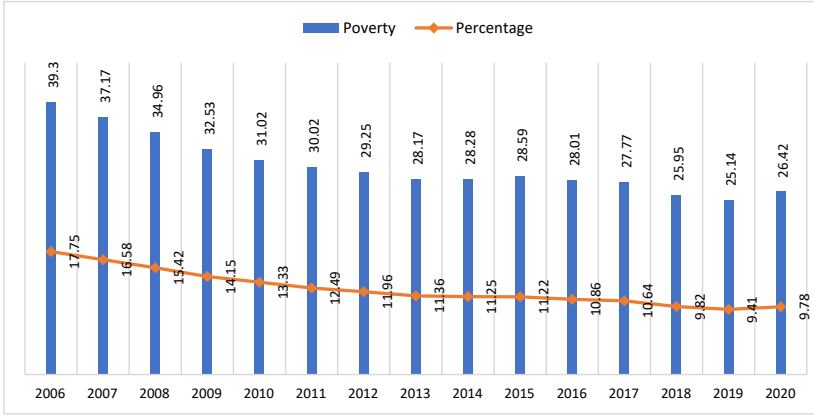

Fig. 21 Poverty in Indonesia (in millions) (Statistics Indonesia, 2020a, 2020b).

in various areas in Indonesia during the first wave of Covid-19 were fluctuating, and in some areas were increasing due to panic buying or abnormal supply (Rozaki, 2020).

3.6.2 Distribution

The Covid-19 pandemic disrupted global food distribution with substantial negative impacts caused by many mobility restrictions worldwide, including

export and import of certain goods (Stephens et al., 2020). National food distribution during the pandemic was also impacted, although currently it is improving again. Food must be distributed to all areas in Indonesia, though some are difficult to reach. These hard-to-reach areas need more support from the relevant parties and how the food can still be distributed. Distribution should take account of the area's population, so the amount of distributed food will not be same in all areas. How the food is distributed will affect the price.

3.6.3 Market

Market function failure happens because the regulation to enable imports makes the country dependent on importing goods (Sulser et al., 2011). When the foreign country's restriction for their export is applied, the import cannot be conducted in the home country. This situation will create more issues in terms of food prices. The market is where the good is sold. With the development of technologies, the market has been developed in physical and online markets. These markets have different characteristics, and the trend in Indonesia shows that consumers prefer to shift to the online market due to its convenience.

Nevertheless, the market cannot be untouched. The control for the market in deciding price needs to be conducted. Many shops hoard supplies when social restrictions are applied, causing food prices to rise steeply (Benton, 2020).

The whole aspect of food accessibility has a strong relationship with the food supply chain. Each agriculture commodity has its own supply chain characteristics. Fig. 22 shows the supply chain pattern of rice in Indonesia, in which each pattern determines the price in the level of farmers and consumers. The longer the chain, the higher the price that needs to be paid by consumers (Susanawati et al., 2021). Understanding the food supply chain can enable win-win solutions for farmers and consumers. Farmers can get the best price to continue to produce, and consumers can get the best price to buy the food. A strategy to cut out the middlemen so farmers can achieve better prices is often stated by experts, but this is not easy in reality. As long as there is no other institution to get the farmer's product to consumers, as middlemen do, middlemen will not be easy to eliminate.

3.7 Who plays the role of food stabilizer?

Food availability, food accessibility, and food utilization are critical to achieving food security. Those aspects must be stable, and thus a stabilizer is needed. Food stability means the food is available over time. Rice and

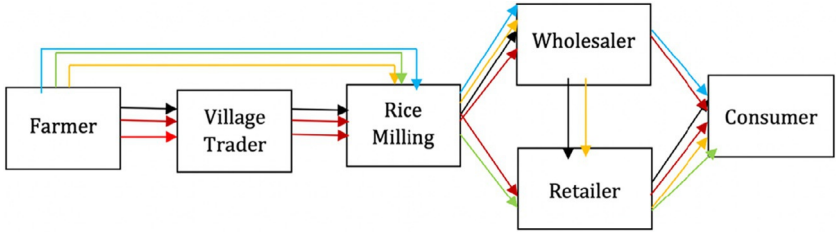

Fig. 22 Rice supply chain (International Center for Applied Finance and Economics (InterCAFE) IPB University, 2018).

other food products are not produced throughout the year, but only in the crop season. During the harvest time, there may be no problem with availability. But how about beyond the harvest season? It is up to related parties to make sure that foods are available over time.

In Indonesia, there are government institutions under the Ministry of Agriculture called the Food Security Bureau and another institution that works on food security issues called the Indonesian Bureau of Logistics. The Food Security Bureau is working to ensure that Indonesia can achieve food security with various programs. Meanwhile, the Indonesian Bureau of Logistics is working on stocking rice and helping to stabilize the rice price by buying from farmers and/or selling directly to the market to control the price. Harnessing the Bureau of Logistics in the food security agenda is a good option. This institution has a warehouse to store food across the country, has its own land to plant rice, and has partnering farmers to provide rice for national or regional stocks. With these capabilities, the Indonesian Bureau of Logistics can contribute to food availability and food stability. The existence of these two institutions does not mean that other parties can ignore the food security agenda. All parties are responsible for ensuring food security.

3.8 Awareness of dietary patterns

Food utilization means that people consume food properly, based on human biological needs, including quantity and quality of the foods. Indonesia, in the 1990s, launched a program called "*4 sehat 5 sempurna*" ("4 health and 5 perfect"), which encouraged people to eat four kinds of healthy food (staple food, side dish, vegetables, and fruit) plus milk. Then, in 2014, through the Ministry of Health Regulation No. 41, the government changed the program to "*Pedoman Gizi Seimbang*" ("Balanced Nutrition Guideline").

The program was launched as an improvement strategy from the previous program, and promoted four points of a healthy life: consuming various food types, daily clean life, physical exercise, and maintaining an ideal body weight.

Consuming foods without a good understanding of ideal nutrition may lead to malnutrition. Indonesia still has many malnutrition cases; some people experience chronic malnutrition or stunted growth. Stunted growth cases in Indonesia have remained high—approximately 37% at the national level (Beal et al., 2018). Socio-cultural, educational, agricultural, and food system factors affect this. As one of the main aspects of food security, food utilization often gets ignored, or related parties focus more on food availability.

The Covid-19 pandemic made people more aware of food waste because saving money during the crisis was essential to many, and wasting food is wasting money (Fry-Bowers, 2020). Grote (2014) added that food waste awareness needs to increase, especially during a crisis where many people cannot eat properly. Most Indonesian people consume rice, so regulations regarding food security also about rice should be changed with a food diversification program. Some areas in Indonesia have started consuming food beyond rice, such as maize or sago. This can be a good start for the food diversification program, as sago is a good alternative to rice. In Maluku, for example, all parties are collaborating to encourage sago food diversification to improve local food security (Timisela et al., 2021).

4. Food security challenges and opportunities post Covid-19

The above explanation about the Covid-19 pandemic and food security in Indonesia can be the basis for the challenges and opportunities of food security in the wake of the pandemic. Fig. 23 shows the challenges and opportunities of food security after the Covid-19 pandemic. The classic problems in agriculture, such as inputs, human resources, and agricultural land, will remain challenges in food security efforts. Collaboration to solve these problems will need much effort from all stakeholders. Classic problems that have existed for a long time will need more modern or sustainable solutions than classic methods.

The long history of food security in many countries, including Indonesia, is dependent on rice. This commodity has become key for global food security, especially in Asia. Stability in rice production concerns food

Fig. 23 Food security challenges and opportunities after the Covid-19 pandemic (the author).

security, especially in developing countries (Bandumula, 2018). Focusing too much on rice will lead a country to be rice-dependent. This situation is not sustainable and causes a country to be vulnerable when local production cannot meet demand. Meanwhile, if foreign countries are not allowing exports, the national rice (food) availability will experience instability. Indonesia is focusing heavily on how rice can be produced (Nurliza et al., 2017). One of the main reasons is that the country's majority staple food is rice. This effort is believed to help the food security agenda. Further dependence on rice is not suitable for the country's economy and stability. Thus food diversification is needed to decrease rice dependency.

Regulation that takes the farmers' side as food producers is hoped for by related parties, such as not importing rice during harvest time or other commodities that self-production is possible. No regulation touches all stakeholders' lines to ensure food security (Douglas, 2009). This is because such regulation is influenced by a wide variety of biophysical, political, social, economic, cultural, psychological, and behavioral factors. Education also becomes a challenge for food producers and consumers. Food producers need education to increase production and produce valuable food products that can support food security, such as utilizing the home garden for food production to support food security at a household level (Abdoellah et al., 2020). Meanwhile, consumers need education about food utilization and awareness of food waste. Ruhyana et al. (2020) and Wijaya et al., (2020) added that food security could be improved by increasing household income and education.

The opportunities that have appeared post Covid-19 pandemic are that awareness of food waste is increasing. This is not because people are concerned about the environment but is more to do with saving money. In Indonesia, social capital that shows solidarity for other people in need during the pandemic shows that this country can develop with a community-based program to support other members. Djamhuri (2008) showed that strong social capital in Indonesia could help the economic relief effort impacted by the pandemic. The local potential is more related to food diversification. It is better for those areas to produce other commodities than to force them to produce rice. Food insecurity is felt more by people in poverty, women, and children. Therefore, these people also need more attention for any food security program (Douglas, 2009).

5. Conclusions and recommendations

Many sectors have experienced the impacts of the Covid-19 pandemic. It caused people to lose their jobs, rendered businesses unable to survive, and made economic prosperity more uncertain. The impacts were felt more by vulnerable people such as middle- and low-income people. The consequences of those impacts bring hot issues on food security.

Indonesia is a developing country that is still struggling to achieve food security. Four main aspects in food security are not easy to achieve, with many challenges to be overcome, and the Covid-19 pandemic has only exacerbated these challenges. Although Indonesia is known as an agricultural country, in reality, it is still struggling with classic agricultural issues such as land-use change, human resources, inputs, etc. Indonesia should focus more on improving agriculture intensification for limited farmland, promoting young people to work in the agriculture sector, and corporating agriculture to increase farmers' economics. Relying on imports is more likely to bring other problems in the future. Too much focus on rice as the main commodity for achieving food security also becomes another issue. The food diversification program needs to be pushed more with regulations and actions.

The pandemic has brought not only challenges but also opportunities such as the increase of awareness of food waste, social capital that shows positive solidarity during a crisis, and local potency that get more attention. Understanding the long history of agriculture in Indonesia and local characteristics is required to establish suitable regulations regarding food security after the Covid-19 pandemic. Finally, all stakeholders or related parties need to collaborate to support the food security agenda as it becomes more challenging.

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